SCI LECTURE PAPERS SERIES

INTERESTERIFICATION IN USE FOR THE PRODUCTION OF CONFECTIONERY FATS

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ISSN 1353-114X
LPS 118/2000

Keywords *confectionery fats, CBS, random interesterification, CBE, enzymatic interesterification*

Confectionery fats

The term confectionery fats is used for all vegetable fats which are used in the confectionery industry, but in particularly for Cocoa Butter Alternatives, CBAs, which are alternatives for cocoa butter.

This paper will mainly deal with two different types of CBAs, Cocoa Butter Substitutes and Cocoa Butter Equivalents. Other confectionery fats like filling fats are also made by interesterification today because of the focus on the adverse nutritional effect of trans fatty acids and hydrogenation, but that topic will be covered by other papers.

Cocoa butter is a very unique fat both physically and chemically. It mainly consists of only three different fatty acids, palmitic acid, stearic acid and oleic acid, and mainly three different triglycerides, Palmitic-Oleic-Palmitic, Palmitic-Oleic-Stearic and Stearic-Oleic-Stearic. This composition of very uniform triglycerides provides a unique melting characteristic as all the triglycerides melts within a very narrow temperature range.

Cocoa butter substitutes

The first cocoa butter substitutes, CBSs, were produced more than 100 years ago by Aarhus Oliefabrik A/S in Denmark; but the basic concept of the product is still the same. The physical properties of a CBS are very similar to that of cocoa butter i.e. they are very hard at ambient temperature and up to a temperature just below body temperature. From there they melt very quickly providing a good melt down on the palate and a good flavour release. But the chemical properties are very different from cocoa butter.

The first CBS was based on fractionated coconut oil, a lauric oil, and today CBSs are still based on lauric oils, mainly palm kernel oil. If these triglycerides are mixed with cocoa butter it will form an eutectic blend which will be very different from cocoa butter as the triglycerides will be dissolved in each other. Therefore it is essential in the use of lauric CBS that there is no or only very little cocoa butter in the formulation.

Traditional production of CBS

As mentioned most CBSs are made by fractionation. But there are a number of disadvantages to this process:

- Fractionation is, compared with other processes in the vegetable oil industry, a relative costly process.
- A fractionation process always yields, at least, two fractions, of which the process is optimized to yield the one. But if the second fraction does not have a value similar or higher than the raw material there will be an additional cost added to the primary fraction.
- Fractionated CBSs do not crystallize into a stable crystal morphology, which causes a gray layer on the surface of the product a few weeks after production, known as fat bloom. Today the phenomenon is solved by the addition of crystal stabilizing emulsifiers.

Despite these disadvantages, fractionation is still the preferred method to produce CBSs in Europe and in Asia Pacific because of superior physical and sensory properties of the final product. In the USA interesterification is used in combination with hydrogenation.

Production of CBS by random interesterification

By interesterification the raw material is fully hydrogenated palm kernel oil that becomes steeper melting by random interesterification (Figure 1).

Compared with fractionation, where it is the concentration of triglyceride with similar melting points by removal of the lower melting triglycerides that causes the steeper melting curve, the changed melting properties of interesterified oils are caused by a reformation of triglycerides with more then one long chain fatty acids (more than C16:0) to triglycerides with two medium chain fatty acids (C14:0 and less). These fatty acids have a lower melting point. As can be seen in Figure 1, the fractionated product is steeper melting than the interesterified product and it is more similar to cocoa butter.

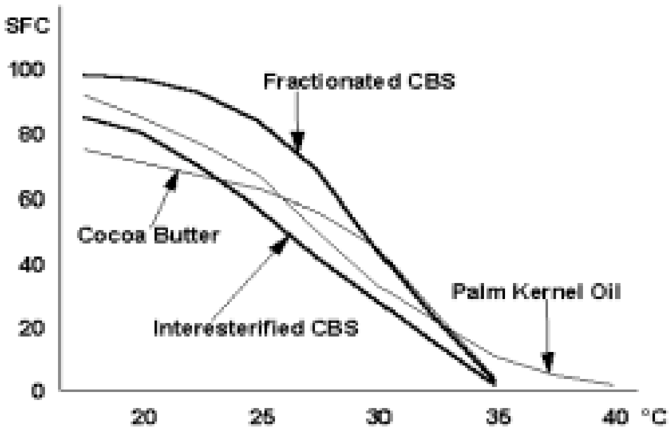

Figure 1

ISSN 1353-114X

Cocoa Butter Equivalents

Cocoa Butter Equivalents, CBEs, are vegetable fats that are equal to cocoa butter, both chemically and physically. This also means that they are fully compatible with cocoa butter and that they can be mixed with cocoa butter in any ratio.

The uniqueness of cocoa butter is its triglyceride composition with a very high content of symmetric triglycerides with the formula S-O-S, where S is a saturated fatty acid, mainly one of stearic acid or palmitic acid, and O is oleic acid. To be compatible with cocoa butter a CBE has to have the same triglyceride structure.

Production of CBE

One way of producing CBE is to use naturally occurring symmetrical triglycerides. These may be achieved by fractionation of oils like palm oil, shea nut oil or other exotic oils, but it is also possible to change the triglyceride composition of a given oil by interesterification.

Theoretically the right triglyceride may be achieved by random interesterification. A random interesterification of a blend of palmitic acid, stearic acid and oleic acid in the right proportion will yield a statistically random amount of all the possible triglycerides, and therefore also a certain amount of the right triglycerides which may be concentrated by fractionation. Pp to now this has not proved to be a feasible process.

Instead the triglyceride may be formed by selective interesterification where enzymes are used as catalysts. The commonly used enzymes are 1,3 specific lipases, meaning that they are only able to hydrolyse and esterify the α-position or the 1 and 3 position of the triglyceride. The raw material used for this process is a triglyceride with oleic acid in the 2 (β) - positions and saturated fatty acids. There are several ways to optimize this process, and in most cases it is optimized to yield stearic-oleic-stearic triglycerides, which are then separated by fractionation and blended with other fractions to make the final CBE. A process may be design as shown in Figure 2.

Instead of stearic acid, palmitic acid may also be used to form palmitic–oleic–stearic triglycerides, but in this case it is impossible to control the formation of palmitic–oleic–palmitic, which is unwanted.

The future of interesterified CBEs

The process of enzymatic interesterification has been protected by patents, but these patents have now expired. The main obstacles against an increased utilization of this process are:

- Legislation. In the EU there is a list of only a few allowed raw materials that can be used for CBE and the interesterification process is not permitted.
- Cost. For the time being the cost of the enzymes is not competitive to other possible raw materials.
- Consumer acceptance. The reaction to GM food has increased the awareness of all aspects of genetic modification, especially in vegetable oil products, but it is a fact that genetically modified enzymes and microorganisms are used in many different food products.

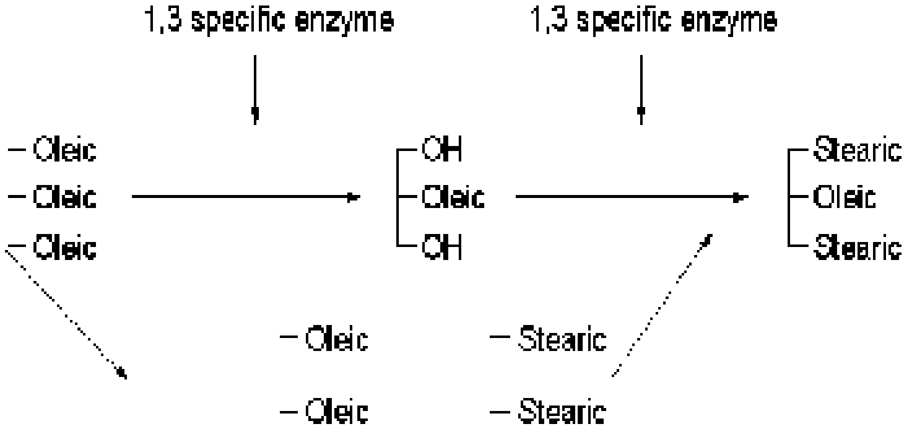

Figure 2. Interesterification of S-O-S

ISSN 1353-114X